

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

Health effects of worker exposures to electromagnetic fields (EMF) have not been conclusively characterized, and there is much controversy surrounding these increasingly ubiquitous exposures. Although residential exposure characterization has received considerable attention (especially for children), comparatively little research has been done to broadly survey occupational exposures. The occupational EMF exposure assessment that has been done has tended to focus on characterizing specialized jobs, such as electrical utility workers or electric train operators, rather than examining common features as concern exposure in a broad spectrum of jobs in the general working population.

In many work sites, such as in offices or small businesses, the contribution of the working environment to EMF exposures remains unclear, but it is likely increasing. For example, government offices, retail outlets, banks, insurance firms, and schools have increasingly adopted computers, video display terminals (VDTs) and other electronic technology over the past decade, so that the use of these devices is now seen in many occupations. Given the widespread use of similar technologies, it seems reasonable to postulate that many jobs may share common work activities with similar EMF exposures. Although little is known about the biological effects of the various parts of the EMF frequency spectrum, fields of power frequency, also called extremely low frequency (ELF), with a range of 30 to 3000 Hertz, are common and are probably increasing in a wide variety of jobs.

1.2. STUDY RATIONALE

Understanding the tasks and conditions that contribute to human EMF exposures can help unravel the controversy surrounding this topic. In conjunction with direct exposure assessment, an exposure-relevant task-based framework can help make sense of exposures in the wide variety of jobs in the present-day labor market. Such an approach can help clarify the relationship between magnetic fields and common exposure surrogates, including job titles or appliance lists that have been used in epidemiological studies. It can also provide guidance for selecting new exposure categories, which are more specific or

sensitive measures of EMF exposure. Further, such new activity surrogates can lead to new hypotheses amenable to testing by re-analyzing existing epidemiological data, for example, the work on EMF exposure and cancer outcomes associated with the use of electric razors, or the association of EMF exposure with the use of sewing machines and neurodegenerative diseases.

The direct measurement of exposure can provide a great deal of detailed information about exposure determinants and conditions, as well as generating hypotheses for *in vivo* and *in vitro* experiments, and suggesting approaches for minimizing or reducing exposures. However, occupational exposure assessments are labor intensive and are often not feasible for the purposes of large-scale retrospective epidemiologic studies. On the other hand, generalized approaches such as job exposure matrices, which attempt to classify exposures based only on available surrogates such as job titles, can oversimplify and therefore misclassify exposures. Important findings about exposure and health risks may be obscured if exposure misclassification leads to a bias toward the null hypothesis of no effect. An intermediate approach, using a set of tasks and their associated known, average exposures, can provide some of the detail of direct exposure assessment, while retaining much of the resource-efficiency of simpler categorical approaches. Along these lines, a task-based time-log approach (a task exposure matrix approach) was developed and evaluated in this study.

1.2 STUDY AIMS

This study aimed to develop, pilot-test, and evaluate a task-based time-log approach to classifying occupational magnetic field exposures. The investigators' intent is that this approach can ultimately be used in the context of epidemiologic analysis, or to survey a population of workers to obtain estimates of group exposure.

Specifically, this study's aims included developing a list of exposure-relevant task categories based on survey data from a general working population. Next, this study aimed to pilot-test this list in a task-based time-log questionnaire instrument in a work setting. A further aim was to measure personal occupational exposures to magnetic fields and directly associate them with the defined set of tasks. Finally, this study aimed to assess the internal

consistency and plausibility of the task exposure model that was developed, and to compare various modelling approaches using this task-based time-log and measured exposure data to derive task specific exposure estimates.

1.4 SCOPE OF WORK

This study's scope of work was, briefly, as follows:

- ◆ Define a set of common work activities that may be associated with EMF exposure. This involved developing a list of common occupations and job descriptions to identify what common work activities (tasks) are of interest across many occupations.
- ◆ Gather measurements of magnetic fields that are associated with these typical activities, model exposures for the various activities, and develop a set of task-specific exposure estimates. This involved screening potential occupational exposure data collected from a variety of published and unpublished surveys done by Eneritech and others. We also attempted to match existing EMF exposure data from a nationwide survey to these activities.
- ◆ Develop task-based time-log questionnaire.
- ◆ Conduct a preliminary evaluation of the approach. The testing consisted of collecting MF exposure data from volunteers and asking them to complete time-activity logs as the basis for this study's exposure assessment. For each subject, we generated estimates of their MF exposure based on their recorded tasks. We compared these exposure estimates to measured exposure data from the same subjects. This also included evaluating how much occupational EMF exposure varies between tasks and individuals, how does this compare to exposure attributable to individual daily activities and to the residential exposure contribution.
- ◆ Compare methods of data analysis and interpretation. Data was reduced to create task-specific exposure estimates and predicted workday means (time-weighted average, or TWA values). Data modeling used both a classical analysis of variance (category) design for the between subject component of personal exposure readings, and a robust

regression method of estimation. Mean exposure components for specific activities were compared for different estimation methods, and activity exposure estimates were compared across various jobs. Spot measurement and personal exposure data were collected, to help assess the contribution of specific MF sources and work environments within jobs.